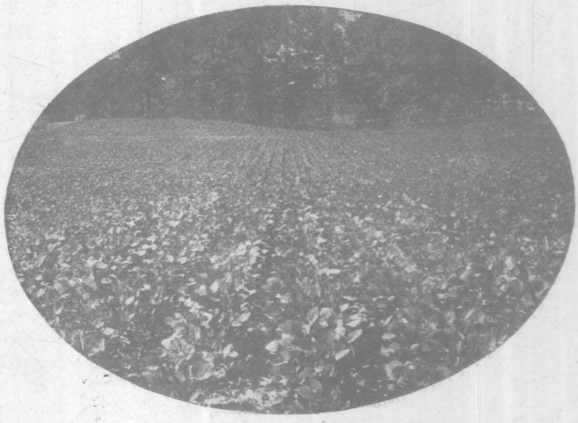
THE SOYBEAN AND COWPEA

OHIO
Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., FEBRUARY, 1912.

BULLETIN 237



Soybeans, July 27, forty-seven days after planting.

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BULLETIN
OF THE
Ohio Agricultural Experiment Station
NUMBER 237 FEBRUARY, 1912.

THE SOYBEAN AND COWPEA

C. G. WILLIAMS AND F. A. WELTON

The soybean (*Glycine hispida*) is a summer annual which belongs to the family *Leguminosae*. It is an erect, hairy, bushy plant and from one and one-half to four feet tall. It usually has one main stem, on which there are from three to nine—usually five or six—branches. The leaves are trifoliate. The blossoms are borne in clusters and are purplish or whitish in color. The pods are from one to two and one-half inches in length, hairy, yellowish or brownish in color, and bear from one to four—usually two or three—seeds. The seed is smooth, roundish, somewhat compressed, and in color may be yellow, green, brown or black with varying shades between.

The soybean is a native of China and Japan, where it is claimed to have been grown for many centuries. It is thought to have been introduced into Europe in the latter part of the eighteenth century. For many years after it was introduced into the United States it was grown only as an ornament. Within the last twenty or twenty-five years it has gained considerable prominence in the agriculture of several states, notably Massachusetts and Kansas, into both of which states the seed was imported direct from Japan. The wide variations in different varieties as regards time of maturity, permit it to be grown pretty generally throughout the United States. Roughly speaking, the earliest varieties can be grown successfully as far north as corn. In Ohio the acreage at present is not large, but is rapidly increasing. The Ohio Experiment Station has been growing soybeans continuously in a small way since 1894. From year to year the acreage has been gradually increased, until now about fifteen acres are grown annually.

THE SOYBEAN

USES

Soybeans are used chiefly as food for mankind and livestock, and as a soil renovator. In China and Japan they are used extensively as human food because they make a fine supplement to the ordinary rice diet, but in this country they have not yet come into general use for this purpose. In Europe the people are beginning to manufacture an oil from soybeans. The refined oil mixed with other oils is used as a salad dressing. The crude oil is used in the manufacture of soap, paint and other oils which are used for lubricating and lighting purposes. As a stock food they have been fed by several experiment stations with satisfactory results to practically all kinds of livestock, including horses, cattle, sheep, hogs and poultry.

Fig. 1. Soybean plant with leaves removed.

Soybeans are usually utilized as grain, hay and silage, and sometimes, though less frequently, as a soiling crop or as pasture. For comparison of these various feeds with other feeds, as regards composition and digestible nutrients, see Table VIII.

Grain: At the present time soybeans are grown more for grain than for any other one purpose. This is due, largely, to the great demand for soybean seed as well as to the high feeding qualities of the beans. On account of the present small acreage and the rapidly growing popularity of the crop among farmers, the seed has been and still is selling readily at wholesale for $2.00 and upwards per bushel. At these prices and with an average yield—which under average Ohio conditions is about eighteen bushels per acre—it is apparent that for the present at least more can be realized from the grain used as seed than from any other product for which they may be grown. For this reason few, if any, are being fed to livestock at the present time.

However, utilized as feed—and this is the basis upon which the value of the seed will ultimately rest—the soybean cannot be regarded as an extraordinary money crop. Although equal in feeding value to concentrated feeds like gluten meal, cottonseed meal and linseed oil meal, yet if we assume that a fair average price per ton for these concentrates is $33.00, and that eighteen bushels of seed and 1,700 pounds of straw per acre is a good average yield, the value of the crop per acre is approximately $23.50, figuring the straw at $5.66*—its manurial value. However, if the straw be fed, and it is readily eaten by livestock, especially sheep, then the total value of the straw, including its feeding and manurial value, is somewhat greater, and consequently a somewhat greater value will be realized from the total crop. This is little, if any, more profitable than a good crop of oats. Under the best conditions, however, it is possible to secure double the above mentioned yield of soybeans. But as long as they are sold on the basis of their present seed value, even with average yields, they may well be considered as a very profitable substitute for oats, especially in regions where, for one reason or another, oats are unsatisfactory.

When fed to horses and cattle it is desirable to grind the beans; but for hogs and sheep, grinding is not necessary. On account of the high oil and protein content of the beans, the meal should be mixed with some starchy food like corn. By mixing the beans and corn in the proper proportions before grinding, this Station has found that the operation of grinding is greatly facilitated.

Hay: As a hay crop, soybeans can hardly claim a permanent place in a regular rotation under Ohio conditions. But as a substitute crop where others have failed, soybeans have an important place to fill. In case of failure of clover, either old or new seeding, or of some spring crop like oats or barley, the land can be utilized to excellent advantage in growing a crop of soybean hay. In quality, good soybean hay compares very favorably with alfalfa. It is a little richer than clover. Since the greater part of the nutrients are contained in the leaves, if many of these are lost in harvesting the quality of the hay will be much poorer. At best, with most varieties, the stems are more or less coarse and woody. But by exercising proper care as regards rate of seeding and time of harvesting, much can be done to overcome these objections. For notes in regard to these matters see pages 248 and 249.

Silage: Soybeans alone do not make satisfactory silage. Although it may keep perfectly sound it sometimes imparts a disagreeable taste to milk and butter. But when mixed with corn in

* Estimated from valuations given soybean straw by Dr. C. G. Hopkins, in "Soil Fertility and Permanent Agriculture," page 154.

the proportion of two parts, by weight, of corn to one of soybeans, the resulting silage imparts no disagreeable odors, and in the experience of this Station has given very satisfactory results, especially when fed to dairy cows. If convenient it will be found desirable to mix the two as they go into the silo; if not, one can put in one load of beans and then two of corn, etc. Attempts made by this Station to grow the beans with corn have usually resulted in failure. Seldom have the beans made anything like a satisfactory growth when thus planted. Since the amount of digestible protein and fat in soybean silage is approximately double that in corn silage, the desirability of the mixture is apparent. But since good silage corn will yield about twice as many tons per acre as will soybeans, it is a question whether the growing of soybeans for silage, as a supplement to corn silage, is profitable, except where farming conditions are such that it is the part of economy to grow rather than to buy the necessary concentrates. As silage, soybeans are almost completely utilized, and are harvested with the greatest ease and with the least waste.

Soiling crop: Among the list of soiling crops, experiments have shown that soybeans have an important place. Since they cannot be seeded with safety until all danger of frost is past, they are not available for feeding until late summer or early fall. They are not quite as palatable as peas and oats, but since they thrive in the hot sun of midsummer they are more satisfactory for soiling purposes in August and September than are peas and oats. The yield of green forage varies considerably, ranging from five to ten tons per acre. Being high in protein, soybeans may be fed to good advantage with some of the less nitrogenous soiling crops like corn, millet or sorghum.

Pasture: Soybeans are occasionally grown for pasture, especially for hogs; for such use the Animal Husbandry Department of this Station has found them quite profitable though not equal to rape. Ordinarily, they are not ready to pasture until six or eight weeks after seeding. So far as this Station is aware no varieties especially adapted to pasturing have as yet been developed. In years when beans shatter badly, hogs should be turned in to utilize the waste beans.

Soil renovation: By means of microscopic organisms found in nodules which usually develop on their roots, soybeans, like all leguminous plants, are able to take up free nitrogen from the air and to cause it to unite with other elements in such a way that it eventually becomes available plant food.

The relative value of soybeans and clover as soil builders depends upon what use is made of the crops. If they are removed, no nitrogen is retained by the soil except that contained in the roots and stubble, and according to Dr. Hopkins,* a ton of air dry clover hay leaves about twenty pounds of nitrogen in the roots and stubble upon which it grew, while a ton of thoroughly air dry soybean hay leaves in its roots and stubble about six pounds. Therefore, on a basis of equal yield, clover stubble adds more than three times as much nitrogen as soybean stubble. But if the whole crops are plowed under, as is done in green manuring, then if the yields of each are the same, the amount of nitrogen added in each case is about equal. As a rule, soybeans and clover yield about the same amount of green forage per acre.

Soybeans have one advantage over clover due to greater rapidity of growth and to wider range of seeding time. They may be seeded late in the spring after failure of some crop. Thus seeded, a full crop of hay or seed may be removed or the whole crop may be utilized for green manuring. Then, again, some farmers seed soybeans with corn just before the last cultivation, and in some seasons an excellent growth for green manuring is made. Orchardists are beginning to use them as a catch crop, seeding in midsummer after having practiced clean cultivation during the early part of the season.

Another purpose for which soybeans are promising, is as a regular crop in a four or five-course rotation. A few years ago this Station substituted soybeans for oats in one of its four-course rotations, thereby establishing a four-year rotation of corn, soybeans, wheat and clover. Thus far the soybeans have been rather more profitable than oats, and, from the standpoint of fertility, two legumes in a rotation are undoubtedly better than one. That soybeans are a most excellent crop after which to seed wheat has been shown by the yields of wheat obtained in this rotation. There is also a decided advantage in preparing a seed bed after soybeans, both as regards time of preparation and amount of work involved. Whether soybeans have been grown in rows and cultivated, or whether they have been drilled solid is immaterial. In either case plowing the stubble for wheat is unnecessary. Thorough disking is sufficient.

CULTURE

Soils, fertilizers and inoculation: The adaptation of soybeans as regards soil is similar to that of the common field bean. On rich

* "Soil Fertility and Permanent Agriculture," page 223.

lands they produce an abundance of forage, though not always as much seed as on land of only fair fertility. Good drainage is an advantage, yet they do fairly well on quite wet soil. Some varieties are quite drought resistant. They are not as sensitive to lack of an abundance of lime carbonate as are clover and alfalfa.

When grown on rich corn land, or following corn grown on well manured sod, no fertilization is necessary. For good results on poor land they should receive a dressing of stable manure or of commercial fertilizer. However, after the soil becomes thoroughly inoculated, the use of nitrogenous fertilizers may well be discontinued.

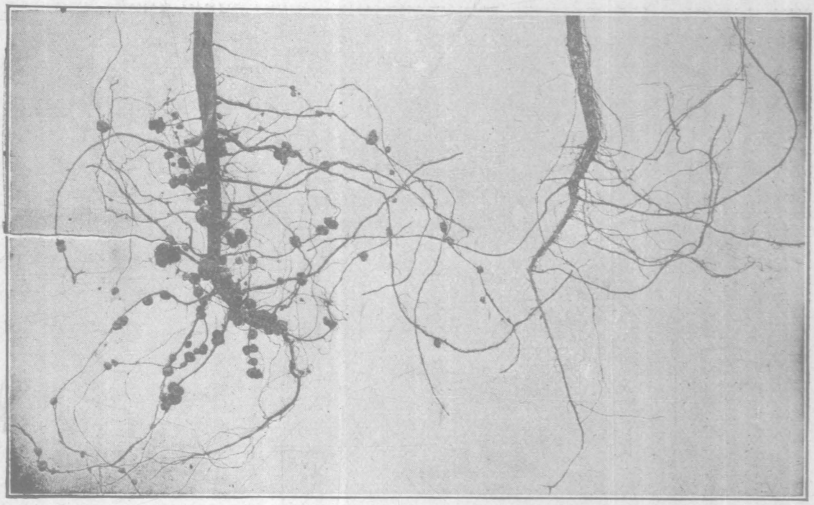

Fig. 2. Soybean roots with and without nodules. *From Vivian.**

The time required to effect inoculation seems to vary a great deal in different localities. In Connecticut, for instance, it required at least three years, while at the Kentucky Station nodules were found the second year. At this Station no nodules have been found the first year, but in the second year they have appeared in considerable numbers. In 1911, soybeans were planted in a field in which they had never been grown. Not a single nodule was found there during the season; but in a field where they had been grown in 1907, the crop of 1911 showed an abundance of nodules. Roots with and without nodules are shown in Fig. 2. Inoculation may be hastened by drilling or broadcasting from 100 to 400 pounds per acre of soil taken from a well inoculated soybean field. A smaller quantity may be successfully used, providing the beans are drilled

*First Principles of Soil Fertility. Orange Judd Co.

in rows twenty-eight or more inches apart, and the soil is distributed only in the rows, using the fertilizer attachment. Although not necessary, especially on rich land, yet under all conditions the development of nodules is desirable, because as a result of their presence the drain upon the supply of nitrogen in the soil is diminished.

Seed bed: Soybeans require a seed bed similar to that required by corn. Consequently the operations employed in its preparation are practically the same as for corn.

Cultivation: When planted in rows twenty-eight or more inches apart, inter-cultivation should, of course, be practiced. They should have from two to four cultivations during the early part of their growth. If planted twenty-eight inches apart, a one-horse cultivator will have to be used—one having fourteen or fifteen harrow teeth is preferable. With a large acreage, where it is desired to use two-horse cultivators, it will be well to make the rows a little further apart. All cultivations should be shallow and level.

When drilled in rows sixteen inches apart (every other hoe) or when drilled solid, soybeans are often greatly injured by a rank growth of foxtail. This can be largely overcome by running a weeder over the bean fields before the beans come up, and again when they are about three inches high. Avoid using it when the beans are just coming up, and after they are up the work should be done in the middle portion of the day when the beans are tough. Such use of the weeder on beans thus drilled is almost indispensable, as it is the only cultivation that can be given them. The best work is done by driving across the drill rows. It is well also to use the weeder on beans which are to be cultivated, both before and after they are up.

Time of seeding: Soybeans should not be seeded until after all danger of frost is past and the soil is thoroughly warmed through. In the latitude of Wooster, conditions are usually favorable the last of May or the first of June.

Rate of seeding: The rate and method of seeding soybeans depends upon the use to which the beans are to be put. For the past three years this Station has conducted in duplicate a "Rate and method of seeding test," in which soybeans were drilled in rows twenty-eight inches apart and at the various rates of one, two, three and four pecks per acre. On a fifth plot they were drilled solid at the rate of eight pecks per acre. The results of these tests are given in Table I.

Regarding the yield of grain, the three-peck rate of seeding gave the highest average yield, and, with the exception of the year 1910,

it gave the highest yield in each of the three years. The net return from three pecks exceeded that from one peck by 3.36 bushels; that from two pecks by 1.85 bushel; that from four pecks by .63 bushel, and that from eight pecks drilled solid by 6.18 bushels. The variety used in this test was the Medium Green.

TABLE I. RATE AND METHOD OF SEEDING

Rate of seeding per acre Pecks	Method of seeding	Yield per acre								
		Total number of pounds				Threshed grain (bushels)				
		1909	1910	1911	3-yr. av.	1909	1910	1911	3-yr. av.	Net return
1	Rows 28 inches apart	2,480	2,685	4,510	3,225	10 66	18.91	35 58	21 72	21 47
2	Rows 28 inches apart	3,640	2,775	4,216	3,544	16 58	20 08	33 78	23 48	22 98
3	Rows 28 inches apart	3,760	3,010	5,040	3,937	17 33	21 00	38 40	25 58	24 83
4	Rows 28 inches apart	3,610	3,345	4,608	3,864	16 08	23 16	36 35	25 20	24 20
8	Rows 8 inches apart	3,080	4,300	5,393	4,258	12 66	15 42	33.86	20 65	18.65

On account of variation as regards size of seed it is to be expected that results would differ somewhat with different varieties. The condition of the soybeans as reported in Table I is too far advanced to make good hay, but the total yield may be taken as a fair indication of the relative yield of hay to be expected from the different rates of seeding.

Although the seeding at the rate of eight pecks per acre gave the highest yield of total forage, yet it was not enough greater than that produced by the use of three and four pecks per acre to pay for the extra amount of seed used. However, the eight-peck rate of seeding gave a much more satisfactory forage as regards fineness of stems.

For silage, fineness of stem is of no particular moment, because the juices of the silo soften coarse, woody stems so that practically all parts of the plant are readily eaten by livestock. And since the yield of forage from the use of three pecks of seed per acre was but a trifle less than that from the use of eight pecks per acre, it would seem that when soys are grown for the silo it is the part of economy to drill them in rows, using about three pecks of seed per acre.

In a similar test, conducted in 1910 in cooperation with the Experiment Station, Mr. I. S. Cook, Jr. of Ross Co., Ohio, also found that three pecks of seed per acre gave the highest yield of seed. The results of Mr. Cook's "Rate and method of seeding test" are given in Table II.

Manner of seeding: The "oats feed" of an ordinary grain drill works very satisfactorily in seeding soybeans. By stopping a part of the runs, the distance between the rows can be varied to suit conditions. On account of the unreliability of some drills to

measure accurately the rate of seeding, and on account of the wide variation in size of seed of different varieties, it is important to *test out* a drill before time of seeding. This may be done by lifting one wheel and *turning off* a small fractional part of an acre. Under ordinary conditions, the beans should not be planted deeper than one inch.

TABLE II. RATE AND METHOD OF SEEDING
(Cooperative experiment by J. S. Cook, Jr.)

Rate of seeding per acre	Method of seeding	Yield of seed per acre (bushels)			Net return
		First series	Second series	Average both series	
One peck	Rows 28 inches apart	14.55	17.60	16.07	15 82
Two pecks...	Rows 28 inches apart	15.52	19.80	17.66	17.16
Three pecks . ..	Rows 28 inches apart	16 00	20 24	18 12	17.37
Four pecks. . .	Rows 28 inches apart	13.74	18 70	16.22	15 22
Eight pecks.. ..	Rows 8 inches apart	12.12	... .	.....	....

HARVESTING

Hay: The harvesting of soybeans is the most difficult work connected with the growing of the crop. No satisfactory machinery especially adapted to handling them has as yet been placed on the market. However, they can be successfully harvested by the use of the same implements as are employed in harvesting general farm crops.

The time to harvest depends upon what use is to be made of the crop. If used for hay, they should be cut as soon as the pods are well formed, because at this stage practically no leaves will be lost in handling, and the beans are at their best as regards the quantity of digestible nutrients and palatibility. If allowed to go much beyond this stage, the stems rapidly become woody and are not readily eaten by some kinds of live stock, particularly cattle.

In a general way the same rules obtain in the curing of soybean hay as in the curing of clover hay. On account of the great ease with which the leaves drop off when dry, it is essential that the greater part of the curing be done in hay cocks. A common practice is to mow in the afternoon and then, after allowing the forage to lie in the swath from twenty-four to forty-eight hours, to pile it in hay cocks. After two or three days of fair weather it is ready to haul. The hay cocks should be opened a few hours before hauling.

Silage: For silage, soybeans should be cut after the beans are well formed, but before the leaves begin to drop. This will be several days later than the time at which they should be cut for hay.

If varieties of corn and soybeans adapted to a given locality be planted at the normal dates of seeding, both will be ready for the silo at approximately the same time.

The best, and an altogether satisfactory implement with which to cut soybeans for the silo, is the ordinary binder. The beans can be handled in bundles easily and without waste.

Seed: When soybeans are harvested for seed they should be cut before the beans are entirely ripe. The degree of maturity to which they should be allowed to come varies both as regards season and variety. For instance, they should be cut at an earlier stage of maturity in a hot, dry fall than in a cool, moist fall. But in almost any kind of a season some few varieties can be left with little or no loss of seed until time of maturity.

As a general rule, soybeans should be cut for seed after the pods have lost their natural color and have taken on a brownish or blackish appearance. At this stage of maturity half or two-thirds of the leaves will have fallen from most of the plants.

For the harvesting of soybeans for seed, probably the best machinery available is either the ordinary mower with side-delivery attachment, or the old time self-raking reaper. If the beans are cut quite green, the mower without the attachment can be used with fair success, but if they are fairly ripe, the use of the attachment is almost indispensible, since otherwise the loss of beans in the swath, through contact with the passing mower, is excessive.

Soybeans cut for seed require practically the same handling in the field as soybeans cut for hay. However, in case of rains, which are sometimes more frequent and heavy at this later season, the hay cocks must be turned from time to time in order to prevent the beans from lying upon the ground too long, in which case they are apt to mold.

Threshing: While it is essential to have soybeans well cured before threshing, yet at the time of threshing it is desirable that they be damp or "tough." In this condition they can be threshed in an ordinary threshing machine with very little cracking of beans, providing the machine be run slowly and with blank concaves. But if the beans be over dry, even with these precautions the amount of cracking will be considerably increased. If beans are used for feeding purposes this is not important, but for seed it is objectionable.

When thoroughly dry, soybeans can be easily threshed by hand with a flail, and, if one has only a small acreage—say, an acre or two—this method is quite practical.

After the beans are threshed they should be spread out on a floor and shoveled over from time to time until they are thoroughly

dry, after which they may be safely put into sacks or bins. If stored away immediately after threshing they are likely to heat and mold. This is probably due in part to their high content of water at threshing time.

VARIETIES

The classification of soybeans is usually based upon variations as regards color of beans and time of maturity.

While a large number of varieties have been tested within the last few years by many of the experiment stations, yet only a few varieties have found their way upon the market.

Within the past four years the Ohio Station has tested about eighty different varieties and strains, including a large number of pure line selections, developed by means of the duplicate plant-row test. There have been some one hundred or more single plant selections tested each year for the past five years. From year to year the poorer selections have been dropped from the annual variety test, and new selections advanced to it from the plant-row work. Previous to 1910 the Station's variety test contained about forty varieties each year. In 1909 small samples of a number of varieties were received from the U. S. Department of Agriculture, and in that year they were grown in the Station's duplicate plant-row test. Of the twenty-eight varieties received, only twelve matured seed. These, with the exception of the poorest, together with several pure line selections, were added to the variety test of 1910, thus increasing the number of varieties to fifty-two. In 1911, fifty-five different varieties were tested.

In this work the beans were planted on one-fortieth acre plots, in rows twenty-eight inches apart and in hills one foot apart in the row. In order to secure a uniform and perfect stand they were planted by hand, dropping, as far as possible, four beans per hill. When five or six inches high they were thinned to a uniform stand of two plants per hill. On account of variations in the land it has been found advisable to use every sixth plot as a check, and upon these plots the Medium Green variety has been grown. In this bulletin a report is given of the different varieties and the most promising selections which have been tested two or more years. The selections are designated by a number, before which is placed the word "Ohio." The left hand figure in each number indicates the year in which the selection was made. For instance, the selection "Ohio 7403" was originated in the year 1907.

Table III gives a partial description of the various varieties and selections.

TABLE III. DESCRIPTION OF VARIETIES OF SOYBEANS

Variety	No. beans per 10 grams	Color of beans	Manner of growth	Date of bloom	Color of bloom	Av. height of plants
Amherst	44	yellow	erect	7-27	purple	23
Auburn	65	black	sl. sp.	7-25	white	23
Chestnut	52	yellow	erect	7-21	purple	22
Cloud	113	black	sl. sp.	8-6	purple	32
Ebony	91		erect	7-24	purple	26
Habaro	65	yellow	"	7-22	purple	24
Ito San	61	"	"	7-22	purple	25
Ito San 17268	47	"	"	7-21	purple	22
Manchuria	67	"	"	7-21	white & pur	21
Medium Green	71	green	"	7-28	purple	26
Ohio 9110	54	"	"	7-26	purple	24
Ohio 9122	54	"	"	7-24	purple	24
Ohio 9001	48	olive	"	7-23	white	24
Ohio 7476	45	"	"	7-24	white	28
Ohio 7420	37	yellow	"	7-26	purple	25
Ohio 7455	50	brown	"	7-30	purple	27
Ohio 9035	45	"	sl. sp.	7-31	purple	27
Ohio 7406	38	yellow	" "	7-24	purple	24
Ohio 7495	44	"	" "	7-24	purple	23
Ohio 7496	42	"	erect	7-26	purple	25
Ohio 7403	42	"	"	7-28	purple	21
Ohio 7490	37	"	"	7-29	purple	27
Ohio 7491	37	"	"	7-28	purple	25
Shingto	49	olive	"	7-25	white & pur	23
Mammoth Yellow	45	yellow	"	9-9	white	35
Mikado	62	"	"	8-2	purple	28
Mongol	63	"	"	8-2	purple	30
Sable	132	black	"	8-10	white	32
Taha	43	blk & yel.	spreading	8-5	white	36
Wing's No. 1	83	black	erect	7-31	white	28
Wisconsin Black	70		"	....	.....	29
Yosho	47	olive	"	7-21	white	28

Additional data, together with the yield per acre of beans and straw, are given in Table IV.

Regarding the beans, the yields for each year as well as the average for 4-year and 2-year periods are given. A study of the data for the separate years shows that no one variety has stood at the head of the list throughout the four years. On the contrary, a different variety ranked first each of the first three years. In 1910 and 1911 the same variety, Ohio 9035, stood at the head of the list. Fluctuations of this sort, which are observed in all kinds of variety testing, may be expected as a result of variations in seasons and soils.

Considering only those varieties which have been grown four years, the six standing highest in the order of their rank are: Ohio 7406, Ohio 7496, Ohio 7403, Ohio 7490, Ohio 7495 and Ohio 7420. Ohio 7406, Ohio 7496 and Ohio 7495 are all pure line selections from the same variety. While Ohio 7495 ranks only fifth, it should be noted that in 1908 it ranked first, thus showing that in some seasons it is a bean of relatively high merit. Ohio 7403 and Ohio 7490 are pure line selections from another variety. In 1909, Ohio 7403 stood at the head of the list. This bean, however, has the disadvantage of being a little weak in the stems. As the plants approach maturity

many of the stems with their weight of beans partially split off from the main stalk. This is a serious objection to this bean for the reason that the mowing machine fails to cut off many of the broken-down stems. While Ohio 7490 has never ranked first in any test at this Station, yet in 1911, in a cooperative test, containing sixteen varieties, conducted by Mr. Wm. McD. Stone of Portage county, it held that distinction. Ohio 7420 is a strain with exceptionally large beans, and in most years it yields well. In 1909 it ranked second.

TABLE IV. THE YIELD OF GRAIN AND STRAW

Variety	Av. date of maturity	Av. number days to maturity	Yield per acre: Beans (bushels) 1908	1909	1910	1911	4 yr. av.	2 yr. av.	Straw (lbs.) 4 yr. av.	2 yr. av.	Pounds straw per bushel grain	Retention of beans
Amherst	10-1	125	.. .	.....	19.02	31.82	.....	25.42	.....	1,840	72	Good
Auburn..	9-24	118	.. ..	.....	13.25	24 98	.....	19.11	.....	1,595	83	Good
Chestnut	9-22	116	.....	.....	15.22	28 17	...	21.69	.....	1,640	76	Good
Cloud	10-11	135	.....	.....	10.95	26 40	.....	18.67	.....	2,170	116	Good
Ebony	9-29	123	.....	.....	14 31	27.32	.....	20.81	.....	1,860	89	Good
Habaro	9-22	116	.....	.....	15 01	24.70	.....	19 85	.....	1,580	80	Good
Ito San	9-18	112	14.12	20.38	13 74	25.54	18.44	19.64	1,955	1,640	84	Ex.
Ito San 17268	9-22	116	.....	.....	13.96	27.81	.....	20.88	. ...	1,725	83	Ex.
Manchuria	9-18	112	.....	.....	11.75	27 98	.....	19.86	.....	1,320	66	Good
Medium Green	9-24	118	14.35	19.81	13.86	30 90	19.73	22.38	2,451	1,717	77	Fair
Ohio 9110	9-25	119	.....	.....	15.69	34.15	.. .	24.92	.....	1,685	68	Fair
Ohio 9122	9-23	117	.....	.....	17 02	31.82	.....	24.42	.....	1,910	78	Fair
Ohio 9001	9-20	114	....	....	17 31	30 90	....	24 10	.....	1,640	68	Fair
Ohio 7476	9-29	123	15 80	25.50	12 19	33.84	21.83	23.01	2,465	1,850	80	Fair
Ohio 7420	9-25	119	19 35	27 59	15.64	28.48	22.76	22.06	2,697	1,760	80	Fair
Ohio 7455	10-4	128	17.07	24 64	14 08	30 51	21 57	22.29	2,020	1,745	78	Ex.
Ohio 9035	10-8	132	.....	. .	19.63	37.37	... .	28.50	....	2,275	80	Ex.
Ohio 7406	9-28	122	24.00	26.37	16.45	31.78	24 65	24.11	2,517	1,565	65	Fair
Ohio 7495	9-23	117	24.94	23 43	14 03	31 34	23.43	22 68	2,782	1,440	63	Fair
Ohio 7496	10-1	125	23 96	23.81	16 20	34.62	24 64	25.41	2,675	1,920	76	Fair
Ohio 7403	9-30	124	20.27	27 98	15 69	33.34	24 32	24 51	2,545	1,510	62	Good
Ohio 7490	10-7	131	19.11	26.37	17 30	33.21	24.00	25.25	2,404	1,930	76	Good
Ohio 7491	10-7	131	.....	25.35	19.41	31 60	.....	25.50	.....	2,085	82	Good
Shingto	10-2	126	.....	.....	15.55	31 74	... .	23.64	.....	1,660	70	Good
Varieties tested but one year—1911												
Mammoth Yellow	.....	.....	not mature									
Mikado	10-12	137	.....	.....	....	27.57	.....	.....	.....	2,120	77	....
Mongol	10-8	133	.....	.....	... .	29 81	.....	. ...	. ...	1,840	62	....
Sable	10-16	141	.....	.....	.....	19.06	.....	.....	. ...	2,300	121	....
Taha	10-16	141	.....	. ..	.....	29.45	.. ..	.....	.....	2,720	92	....
Wing's No. 1	10-4	129	.....	. . .	. ...	25.98	.....	.....	.....	1,640	63	....
Wisconsin Black	9-14	111	.....	14 86	.....	.....	.....	.....	.....	.....	.	....
Yosho	10-3	128	.....	.....	.....	25 58	.....	.....	.....	2,080	81	....

Since many of the varieties have not been grown four years, the two-year average yield offers the only criterion by which to make a comparison of all the varieties, including those received from the U. S. Department of Agriculture, and the more recent selections. Upon this basis, the six varieties standing highest in the order of their rank are: Ohio 9035, Ohio 7491, Amherst, Ohio 7496, Ohio 7490 and Ohio 9110. Of this list, two—Ohio 7496 and Ohio 7490—

appear also among the six highest based upon the four-year average yield. The Amherst is a variety received from the U. S. Department of Agriculture and it is claimed by that Department to be a selection from the same original variety as Ohio 7490 and Ohio 7491. Ohio 9110 is a pure line selection from one of the most common varieties—the Medium Green. Like the Medium Green it is liable to shatter badly, especially in unfavorable seasons. Ohio 9035 seems to be a strain of exceptionally high merit. It not only has the highest two-year average yield but it ranked first in both the years in which it was tested. A near relative of this bean, Ohio 7455, which was developed from the same variety, ranked second among sixteen varieties in a cooperative test conducted by Mr. Wm. McD. Stone in Portage county in 1911, and it stood first in a test containing eight varieties at the Paulding county test farm in 1911. For the retention of beans, these two varieties are among the best this Station has ever grown. They came from a variety which has shown itself to be practically free from shattering in the most unfavorable seasons; seasons in which other less resistant varieties lost practically all of their beans. The fineness of their forage also places them among the best for hay purposes. Although not included among the six highest yielders of either the four or two-year average yields, Ohio 7476 is a strain of considerable merit. Out of a total of fifty-five varieties tested in 1911 it ranked fourth. Ohio 9001 is a later selection from the same variety as Ohio 7476. Ohio 9122 is another pure line selection from the Medium Green. Its two-year average yield exceeds that of the bulk Medium Green by 2.04 bushels.

Retention of beans is a matter of considerable importance, especially if the weather be dry and hot at harvest time. Beans which shatter badly should be cut while they are a trifle green. However, such beans will need a little extra care after threshing in order to prevent molding.

A further study of the data in Table IV shows that the early varieties yield somewhat less than the medium or late varieties. This fact is better brought out in Table V.

This Station has never conduced a variety test of soybeans in which they were cut for hay, and for that reason has no data regarding their relative value so far as quantity of hay is concerned. But for hay, *quality* is likely a better criterion by which to judge than *quantity*. At best, soybeans make a rather coarse hay. However, there is a marked difference in varieties as regards fineness of stems. Of those tested by this Station, the varieties having the finest stems and greatest abundance of forage are the Cloud, Sable,

Ohio 9035, Taha, Shingto, Ebony and Auburn. On account of lateness of maturity the Sable and Taha cannot be safely counted upon, one year with another, to mature seed in northern Ohio. In the two years that the Cloud, Ohio 9035 and Shingto have been tested, they have ripened seed, but the average date of their maturity shows that in some seasons they would likely be cut off by frost in northern Ohio. Killing frosts frequently occur in the latitude of Wooster by Sept. 30. Of the three varieties mentioned the Shingto is less desirable than the other two. The Ebony produces a fair quality of hay and has the advantage of being a little earlier than the other varieties mentioned. It would likely ripen seed in nearly all parts of the state. Another variety of some promise is the Auburn. It is a few days earlier than the Ebony. However, as has already been said, soybeans are cut at an earlier stage for hay than for seed, and for this reason failure to produce seed does not necessarily disqualify a variety for hay purposes. It would simply necessitate the buying of new seed each year.

TABLE V. VARIETIES OF SOYBEANS ARRANGED ACCORDING TO DATE OF RIPENING

Early soybeans (116 days or less)	Average date of maturity	Average number of days to maturity	Two-year average yield per acre		Weight per bushel
			Beans	Straw	
Chestnut	9-22	116	21.69	1,640	59 00
Habaro	9-22	116	19 85	1,580	59.50
Ito San	9-18	112	19.64	1,640	59.00
Ito San 17268	9-22	116	20.88	1,725	60 00
Manchuria	9-18	112	19.86	1,320	59 50
Ohio 9001	9-20	114	24.10	1,640	58 75
Average	9-20	114	21.00	1,591	59.29
Medium soybeans (117-126 days)					
Amherst	10-1	125	25.42	1,840	58 75
Auburn	9-24	118	19.11	1,595	57.50
Ebony	9-29	123	20.81	1,860	58 50
Medium Green	9-24	118	22 38	1,717	58.50
Ohio 9110	9-25	119	24 92	1,685	58.75
Ohio 9122	9-23	117	24 42	1,910	59.00
Ohio 7476	9-29	123	23.01	1,850	59.75
Ohio 7420	9-25	119	22 06	1,760	58 50
Ohio 7406	9-28	122	24 11	1,565	58 50
Ohio 7495	9-23	117	22.68	1,440	58.00
Ohio 7496	10-1	125	25.41	1,920	57 50
Ohio 7403	9-30	124	24 51	1,510	58.50
Shingto	10-2	126	23.64	1,660	59 00
Average	9-27	121	23 27	1,716	58 52
Late soybeans (127-132 days)					
Ohio 7455	10-4	128	22.29	1,745	59 75
Ohio 9035	10-8	132	28.50	2,275	60 00
Ohio 7490	10 7	131	25 25	1,930	59 00
Ohio 7491	10-7	131	25 50	2,085	58.50
Cloud	10-11	135	18.67	2,170	60.50
Average	10 7	131	24.04	2,041	59.55

Soybeans have not been differentiated into varieties as have the cereal crops like corn, oats and wheat. The names "Early Yellow," "Medium Brown," etc., under which most of them appear in seed catalogs, are not, strictly speaking, variety names. They simply describe the beans as regards their color and time of maturity. Under cover of such names there may be a large number of true varieties differing widely as regards yield, manner of growth, fineness of stems, etc. The selections reported in this bulletin were developed from bulk seed thus named.

Below, the name of the bulk seed from which each selection was derived, is placed opposite the name of the selection:

Ohio 9110—Medium Green
Ohio 9122—Medium Green
Ohio 7476—Medium Olive
Ohio 9001—Medium Olive
Ohio 7420—Medium Yellow
Ohio 7406—Medium Yellow
Ohio 7495—Medium Yellow
Ohio 7496—Medium Yellow
Ohio 7403—Medium Yellow
Ohio 7455—Medium Brown
Ohio 9035—Medium Brown
Ohio 7490—Medium Yellow
Ohio 7491—Medium Yellow

The seed on the market passing under these indefinite names may or may not be similar to the bulk seed of which these selections are improved strains.

The Medium Green, sometimes called Early Green, Medium Early Green and Guelph, is one of the oldest and most widely known varieties. With the exception of most of the new selections and two varieties, the Amherst and Shingto, it has given the highest two-year average yield of seed of any variety tested by this Station.

Enemies of soybeans: While soybeans are not altogether free from attacks of fungous diseases and insects, these troubles are not so numerous in Ohio as in some other states. So far as this Station is aware, there are no enemies of economic importance to soybeans in the state. The foliage is rarely injured, never severely, either by fungous diseases or insect pests. The seed is comparatively free from attacks of weevil and other grain insects. Rabbits are fond of the young growing plants and under some conditions may do considerable damage.

THE COWPEA

The cowpea (*Vigna unguiculata*) is a summer annual, and like the soybean, belongs to the family Leguminosae. In general appearance it more nearly resembles the field and garden beans than does the soybean. It is variable as regards its habit of growth. Some varieties are bush-like, sending up a single stem a foot or so in height, on which several lateral branches are borne; others are

trailing, having, in favorable localities, branches fifteen to twenty feet long. Between these two extremes all intermediate forms occur, due largely to variations as regards soil, time of planting and climatic conditions. It is not a true climber like the pole field bean, yet it has slender runners which sometimes twine about adjoining objects. The stems and leaves are not hairy like those of the soybean. The leaves are trifoliate.

The flowers are borne singly and are whitish, purplish or yellowish in color. The pods are usually straw color and vary in length from five to eighteen inches. As regards shape and color of seeds there are great variations. Some are smooth, others wrinkled—the smooth type being the more common. The more common colors are black, yellowish and brownish, with varying shades; they are also frequently mottled. A ring around the scar is not uncommon, and this sometimes gives rise to such variety names as "black-eyed."

The cowpea is said to be a native of the Orient, where it is supposed to have been cultivated for thousands of years. It is thought to have been introduced into this country from the West Indies in the early part of the eighteenth century.

While the cowpea is pretty generally distributed in all the warmer regions of the world, not until recent years has it been regarded as of economic value in this country, except in the South Atlantic and Gulf states. In recent years, however, it has been pushing northward and at the present time some varieties, especially the Black, are looked upon with considerable favor in many of the southern counties of Ohio.

USES

Like soybeans, cowpeas are grown for food and for soil improvement. As food for mankind they are in much more common use than are soybeans. They are relished by all kinds of livestock and are utilized as grain, hay, silage, soiling and pasture. As pasture they are most useful for hogs, because in cattle and sheep they often produce bloat. For comparison with other feeds, as regards composition and digestible nutrients, see Table VIII.

Soil: The cowpea has a wide adaptation as regards soil. Owing to the fact that the length of season in the greater part of Ohio is a little short for the maximum development of the cowpea, sandy and loamy soils are preferable, as these tend to hasten maturity. Although quite sensitive to a wet soil, the cowpea will grow on a poorer or more acid soil than will the soybean, and for this reason it has a somewhat wider adaptation for green manuring

than has the soybean. However, where the soybean can be successfully grown, it is to be preferred because the nitrogen content of the whole plant, also of the roots and stubble, is higher than that of the cowpea.

Seeding and harvesting: With few exceptions the same general rules obtain regarding the seeding, harvesting and threshing of cowpeas as are employed in the growing of soybeans. On account of having a larger and more vigorous root growth, the Kansas Station recommends seeding cowpeas a trifle thinner than soybeans. As a rule, cowpeas should not be cut for hay while they are in vigorous growth. According to reliable reports the best time to cut for hay is when the leaves and pods are beginning to turn yellow.

VARIETIES

In 1905 this Station conducted a cowpea variety test, including fourteen varieties. Only six of these matured seed. For three years thereafter cowpea work was discontinued. In 1909 and the years following a few of the earlier and more promising varieties for this locality, as indicated by the test in 1905, have been grown. The results of this work are shown in Table VI. In the same table, also, are given, by way of comparison, the three-year average yields of ten different varieties of soybeans. With the exception of the yield of total forage of the Black cowpea in 1910, the three varieties of cowpeas yielded less than the average of ten varieties of soybeans for the corresponding years. Regarding the yield of grain, the average of the soybeans for the three years exceeds that of the Black cowpea by 197 percent; that of the New Era by 208 percent and that of the Whippoorwill by 432 percent.

TABLE VI. COMPARISON OF COWPEAS AND SOYBEANS

Varieties of cowpeas	Yield per acre								Weight per bushel
	Total number of pounds				Threshed grain (bushels)				
	1909	1910	1911	Av.	1909	1910	1911	Av.	
Black	3,000	2 760	3,480	3,080	3 50	3.33	17.00	7 94	56 00
New Era	2,680		2,080	2,380	3 33		12 00	7.66	51 50
Whippoorwill	3,000	1,880	2,760	2,547	1.67	2 33	9 33	4 44	51.00
Av. of ten varieties of soybeans	4,068	2,599	3,917	3,528	24.59	14 92	31 35	23.62	58.70

From this table, therefore, it is evident that in this locality soybeans are superior to cowpeas both as regards yield of total forage and threshed grain. And what is true concerning the relative

value of these crops in northern Ohio is likely true of them in central and much of southern Ohio, as has been indicated by a number of tests conducted by the Station in the southern half of the state.

In chemical composition there is also a marked difference between these two crops. This fact is shown in Table VII, which gives data regarding the content of protein and fat in twenty-three varieties of soybeans and two varieties of cowpeas. The percentages given in the table are the average of the analyses of the crops grown in 1910 and 1911.

TABLE VII. PROTEIN AND FAT CONTENT OF SOYBEAN AND COWPEA SEED

Variety	In fresh or air dry material (percent)			Calculated to water-free substance (percent)		Bushels per acre 2 yr. av.	Pounds per acre		Quantity of oil meal (O. P.) equivalent to an acre of soybeans and cowpeas in:—	
	Moisture	Protein	Fat	Protein	Fat		Protein	Fat	Protein (tons)	Fat (tons)
Amherst	5 00	43 59	17.50	45.88	18.42	25.42	664.8	266.9	1 01	1.69
Auburn	6 63	42.16	17.08	45.15	18.29	19.11	483 4	195.8	0 73	1.24
Chestnut	5.03	43.56	17.22	45.89	18.14	21.69	566.9	224.1	0 86	1.42
Cloud	6.67	40 85	15 63	43.77	16.75	18.67	457 6	175 1	0.70	1.11
Ebony	8 80	42 22	15.54	46.29	17 04	20 81	527.2	194.0	0 80	1.23
Habaro	4 72	43.63	18.44	45.79	19 36	19 85	519 6	219.6	0 79	1 39
Ito San	3 72	44.31	17.42	46 02	18.09	19.64	522.1	205.3	0.79	1 30
Ito San 17268	4.06	44 15	17.00	46.02	17 72	20.88	553 1	213.0	0.84	1 35
Manchuria	4.77	40.85	17.86	42.89	18.75	19.86	486.8	212 8	0.74	1.35
Medium Green	6 30	41.38	17.68	44.16	18.87	22.38	555.8	237.4	0.84	1 50
Ohio 9122	4 22	43 09	19.00	44.99	19 84	24.42	631.4	278 2	0.96	1 76
Ohio 9001	6.59	42.06	15 71	45 03	16 82	24.10	608.2	227.2	0.92	1.44
Ohio 7476	6.35	42 12	15.84	45.22	17 00	23 01	581 5	218 7	0 88	1 38
Ohio 7420	5 23	41.72	16.89	44.02	17.82	22 06	552.2	223 6	0 84	1.42
Ohio 7455	6.13	39 50	17.29	42 08	18.42	22 29	528.3	231 2	0 80	1.46
Ohio 9035	2.52	40.76	19.31	41.81	19 81	28 50	697 0	330.2	1 06	2.09
Ohio 7406	4.01	40.26	16.83	41.94	17.53	24 08	581 7	243.2	0 88	1 54
Ohio 7495	5 83	42.77	15.70	45 42	16 67	22.68	582.0	213 6	0.88	1.35
Ohio 7496	4.88	43.28	17.92	45.50	18.84	25.41	659 8	273.2	1.00	1.73
Ohio 7403	5.20	42.44	15.84	44.77	16.71	24 51	624.1	232.9	0.95	1 47
Ohio 7490	4.55	43.40	17.59	45.47	18.43	25 25	657.5	266.5	1.00	1.69
Ohio 7490	6 38	42.00	16 74	44.86	17.88	25.50	642 6	256.1	0 98	1.62
Shingto	3.95	40.59	17 76	42 26	18.49	23 64	575.7	251.9	0.87	1.59
Av. of 23 varieties of soybeans	5.31	42 20	17.12	44 58	18 07	22.77	576.5	234 4	0.87	1.48
Black*	7.95	24.76	.....	26 90	...	7.94	118.0	....	0 18	..
Whippoorwill*	8.41	26.19	1.30	29.59	1.42	4.44	69 8	3.47	0.11	.02
Av. of 2 varieties of cowpeas	8.18	25.37	....	28.24	. . .	6 19	93 9	....	0 14	....

*Analyses of crop of 1910 only. Yields of same are the average of three years.

In this table is also given the quantity of oil meal carrying the same amount of protein and fat as was produced by an acre of the different varieties of soybeans and cowpeas.

The Agronomy Department is indebted to the Station chemist, Prof. John W. Ames, for the analytical work in Table VII.

SUMMARY

1. Soybeans have a wide adaptation as regards soil and climate. In general, the northern limit of their adaptation coincides with that of corn.

2. Soybeans are grown chiefly for hay, grain, silage, soiling, pasture and as a soil renovator.

3. Soybeans should not be seeded until all danger of frost is past and the ground is thoroughly warmed through, which in the latitude of Wooster is usually the last of May or first of June.

4. Three pecks per acre, drilled in rows twenty-eight inches apart, gave the highest yield of seed and the most economical yield of forage for the silo. For best quality of hay they should be drilled solid, using six or eight pecks of seed per acre.

5. For hay, cut when pods begin to form. For grain, cut just before beans are ripe, i. e. when pods are beginning to take on a brownish or blackish appearance. For silage, cut when as near maturity as possible without dropping the leaves.

6. Of the varieties which have been tested four years, the six highest in the order of their rank are: Ohio 7406, Ohio 7496, Ohio 7403, Ohio 7490, Ohio 7495 and Ohio 7420, all of which are "Medium Yellow." Of all the varieties tested in the past two years, including those received from the U. S. Department of Agriculture, and the newer selections developed by this Station, the six highest in the order of their rank are: Ohio 9035 (Medium Brown), Ohio 7491 (Medium Yellow), Amherst (Medium Yellow), Ohio 7496 (Medium Yellow), Ohio 7490 (Medium Yellow), and Ohio 9110 (Medium Green). Of the available varieties on the market this Station has found none better than the Medium Green, also known as Early Green, Medium Early Green and Guelph.

7. Among the earlier varieties those best suited for hay are the Ebony and Auburn. A finer quality of hay is produced by some of the later varieties like the Cloud, Sable, Ohio 9035, Taha and Shingto.

Under Ohio conditions, cowpeas are inferior to soybeans except possibly as a soil renovator on the poorer and more acid soils.

TABLE VIII. COMPOSITION, DIGESTIBLE NUTRIENTS AND FERTILIZING ELEMENTS IN 100 POUNDS OF:—

Name of feed	Total nutrients						Digestible nutrients				Fertilizing elements		
	Water	Ash	Protein	Fiber	Nitrogen free extract	Fat	Protein	Carbohydrates	Fat	Nutritive ratio	Nitrogen	Phosphoric acid	Potash
Soybean silage	74.2	2.8	4.1	9.7	6.9	2.2	2 7	8.7	1.3	1: 4.4	0.71	0.16	0.75
Cowpea silage	79 3	2.9	2.7	6.0	7.6	1.5	1 5	8.6	0.9	1: 7.2	0 43	0.15	0.46
Corn silage	74 4	1 5	2.2	5.8	15.0	1.1	1 1	13.9	0 9	1:14.7	0.35	0.11	0.37
Soybean hay	11.3	7.2	15.4	22.3	38.6	5 2	10.8	38 7	1 5	1: 3.9	2 32	0 67	1.08
Cowpea hay	10.5	14 2	8.9	21.2	42.6	2.6	5 8	39.3	1 3	1: 7.3	1 43	0 52	1 47
Clover hay	15 3	6.2	12.3	24.8	38.1	3 3	6 8	35 8	1.7	1: 5.9	2.07	0 38	2 20
Alfalfa hay	8.4	7 4	14.3	25.1	42 7	2.2	11 0	39 6	1.2	1: 3.9	2.19	0 51	1.68
Timothy hay	15.0	4.5	6.0	29 6	41.9	3 0	2 8	43 4	1 4	1:16.7	1 26	0 53	0 90
Soybeans (grain)*	8 7	5 4	36.3	3 9	27.7	18.0	31 5	22.3	15 3	1: 1.9	5.30	1.87	1 99
Cowpeas (grain)	14 6	3 2	20 5	3 9	56.3	1.5	16 8	54 9	1 1	1: 3.4	3 28	1.01	1 20
Corn (grain)	10.6	1 5	10 3	2 2	70.4	5 0	7 9	66 7	4 3	1: 9.7	1.82	0.70	0 40
Oats (grain)	11 0	3 0	11 8	9 5	59.7	5 0	9 2	47 3	4 2	1: 6.2	1.88	0.82	0.62
Oil meal (O. P.)	9 2	5 7	32.9	8 9	35.4	7.9	29 3	32.7	7 0	1: 1.7	5 43	1 66	1.37
Cottonseed meal	7 0	6.6	45.3	6 3	24.6	10 2	37.6	21.4	9 6	1: 1.2	7 25	3.04	1 58
Wheat bran	11.9	5.8	15.4	9.0	53 9	4 0	12.2	39.2	2.7	1: 3.7	2.67	2.89	1.61

*Results of analyses of this Station are given on page 259.